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RECENT DISCOVERIES OF FOSSIL FISHES IN THE DEVONIAN ROCKS OF CANADA.

BY J. F. WHITEAVES.

DEPOSITS containing remains of fishes remarkably like those of the old red sandstone of Scotland and Russia were discovered by Mr. R. W. Ells, M.A., of the Geological Survey of Canada, in 1879, at Scaumenac bay, on the north shore of the mouth of the Restigouche river, almost immediately opposite Dalhousie. To a certain extent, however, this discovery had been anticipated by Dr. Abraham Gesner, who, in a report on the Geological Survey of New Brunswick, published in 1843, states that in the previous year he found "remains of fish and a small species of tortoise, with fossil foot-prints," in the shales and sandstones of Scaumenac, or as he calls it, of Escuminac bay. Prior to 1879 all the rocks which skirt this bay were regarded as belonging to the Bonaventure division of the Lower Carboniferous, but we now know that at this locality the conglomerates and red sandstones of the Bonaventure series are underlaid, perhaps unconformably, by shales and sandstones of Devonian, and most probably of Upper Devonian age.

On behalf of the Canadian survey, Mr. A. H. Foord has devoted the whole of the summer seasons of 1880 and 1881 and part of the present summer to a systematic exploration of these fish-bearing beds, and has obtained from them an extensive and instructive series of specimens.

The genera and species of fishes collected by Mr. Foord and other members of the survey at Scaumenac bay may be thus briefly indicated.

1. Pterichthys canadensis. By far the most abundant fossil at this locality is a fine species of Pterichthys which has been provisionally described, under the name *P. canadensis*, in the "American Journal of Science" for August, 1880. The specimens collected show nearly all the characters of the helmet, buckler, plastron and pectoral spines in great perfection, but no vestige of the tail has yet been detected, nor of any of the fins other than the pectorals. In the number, contour and disposition of the plates on the upper and under surface of the head and body, and in the shape and mode of articulation of the pectoral spines, the Canadian species agrees precisely with Pander's well known restoration of Pterichthys, but its sculpture is exactly like that of Bothriolepis. The genera Asterolepis and Bothriolepis of Eichwald, it should be premised, were both based upon detached bony plates of fishes from the old red sandstone of Russia, in 1840, and the distinctions between them were founded on peculiarities in their surface ornamentation. In Asterolepis the sculpture of the exterior consists of numerous, minute, isolated, conical tubercles, with radiating striæ around their bases and in the interstices between them, while in Bothriolepis the markings of the same surface consist of shallow pits, perforated by vertical canals and encircled by a more or less complete network of raised ridges. All the species of Pterichthys described and figured by Agassiz in his monograph of the fishes of the old red sandstone have the sculpture of Asterolepis (Eichwald), but the Canadian form which in every other respect is a true Pterichthys, has the pitted ornamentation of Bothriolepis. Pander, however, in his memoir on the placoderms, has maintained that Bothriolepis and Pterichthys are both synonyms of Asterolepis, and the Scaumenac bay specimens certainly show that there is no essential difference between Pterichthys and Bothriolepis. Moreover it is exceedingly likely that the Canadian Pterichthys is specifically as well as generically identical with the *Bothriolepis ornata* of Eichwald, though the latter species has never been described nor figured with sufficient accuracy to be recognized with any degree of certainty.

There are two other points of interest in connection with this species of Pterichthys. In the monograph of the fishes of the old red sandstone already referred to, Agassiz gives an ideal restoration of the genus. In this restoration the front margin of the head is represented as bearing a pair of divergent and slightly curved labial appendages or barbels, which the author in the text claims to have seen in specimens of his *P. latus*, but which he indicates in the diagram by dotted lines, as if in some doubt of their actual existence. These barbels are omitted altogether in Pander's more recent restoration of the same genus, reduced figures of which are reproduced in several of the geological manuals of the day. Yet in one of the specimens collected by Mr. Foord the barbels are plainly visible and do not differ either in shape or position from those indicated in Agassiz's diagram, except that they are a little closer together at their bases or points of attachment. The flattened conical, dermal processes on the upper side of the helmet, one on each side of the orbit, as represented in Pander's restoration, are also well seen in two of Mr. Foord's specimens, though in these they are directed forwards as well as outwards, whereas in Pander's figures they are depicted as though they were bent backwards.

2. Diplacanthus, sp. undt.—An apparently undescribed species, of which only a few imperfect examples have been collected. It appears to be remarkable chiefly for the comparatively small size of its fin spines in proportion to that of the head and body.

3. Acanthodes mitchelli? Egerton.—Ten or twelve specimens of a diminutive acanthodean which seem to be barely distinguishable from the Scotch species named above. The largest perfect individual is not more than an inch and three-quarters in length, and the scales, when examined under the microscope, are seen to be perfectly smooth.

4. Phaneropleuron curtum.—This remarkable genus was first described by Professor Huxley, in 1871, in the tenth decade of organic remains issued by the Geological Survey of Great Britain. Its principal characters are as follows: scales thin, cycloidal, dorsal fin extremely long, single and confluent with the upper lobe of the tail, pectorals and ventrals acutely lobate, jaws armed with a single series of short conical teeth, vertebral centers not ossified. The only species previously known was the *P. andersoni* of Huxley, from the old red sandstone of Dura Den in Fifeshire, a long narrowly fusiform fish whose length is more than five times its maximum height or depth. At Scaumenac bay, in 1880, Mr. Foord obtained four crushed and distorted but nearly perfect examples of a new species of Phaneropleuron, which has since been described in Vol. x, No. 1 of the *Canadian Naturalist*, as *P. curtum*. It is a shorter and broader fish than *P. andersoni*, its length being not much more than twice its height. The largest specimens collected in 1880 are a little more than six inches in length, but an individual found by Mr. Foord at the same locality in 1881 is fifteen inches long.

Professor Cope has shown that of all the Devonian fishes, Phaneropleuron comes nearest to the living *Ceratodus forsteri*, of Queensland, both in its internal and external characters, but the dentition of Phaneropleuron was only partially known. Last summer Mr. Foord was fortunate enough to obtain specimens, showing that in addition to the simple conical teeth with which the dentary bone is armed, the Canadian species is furnished with triangular palatal teeth, each furnished with rows of conical denticles. These palatal teeth are precisely like those of Dipterus as figured by Hugh Miller in the "Footprints of the Creator," and the affinities of Phaneropleuron with the living Ceratodus and with the Dipnoi generally are thus rendered still more apparent.

Eusthenopteron Foordi.—In the same paper as that in which the preceding species was described, the above provisional name was suggested for a number of large fragments of a fish, which, when perfect, must have attained to a length of fully three feet. The largest specimen consists of a portion of the posterior end of the fish about a foot in length, which shows the external characters tolerably well, though the caudal, anal and second dorsal fins are imperfect. The bony supports of each of these fins and about five inches of the vertebral column, or rather of its lateral elements, are beautifully preserved in another specimen. The only parts of the head then recognized were fragments of a dentary bone, with teeth, and some isolated cranial plates, one of which is evidently the operculum.

In the sculpture of the cranial plates, in the shape and ornamentation of the scales of the body, and in the fact that the fin rays of the second dorsal and anal are both supported by three osselets articulated to a broadly dilated spinous apophysis, this supposed new genus very closely resembles the Tristichopterus of Sir Philip Egerton. But it is well known that in many Devonian fishes the notochord was persistent, and Sir P. Egerton calls special attention to the fact that Tristichopterus is an exception to this rule, its vertebral centers being completely ossified. Further, the osselets of the lower lobe of the tail of Tristichopterus are described as "springing from eight or nine interspinous bones." In Eusthenopteron, on the other hand, the vertebral centers do not appear to have been ossified at all, and the osselets of the lower lobe of the tail are articulated to the swollen outer extremities of the hæmal spines.

More recently, in 1871, a number of additional specimens of Eusthenopteron have been collected by Mr. Foord, which throw much new light on its structure. Small specimens show that the peculiar central and accessory lobe developed between the upper and lower lobes of the tail, which suggested to Sir P. Egerton the name Tristichopterus, is common to that genus and to Eusthenopteron. The general shape and position of the fins, too, appear to be sufficiently alike in both genera. The jaws of Eusthenopteron, like those of Tristichopterus, are each armed with an outer row of small teeth, and an inner row of large ones, but the teeth of Tristichopterus are simply conical and circular in transverse section, whereas those of Eusthenopteron are flattened conical with lateral cutting edges. The jaw of Eusthenopteron is remarkably like that of the Asterolepis of Hugh Miller, but not of Eichwald, as figured in the " Footprints."

Glyptolepis. Compare *G. microlepidotus* Ag.—A single badly preserved example of a species of Glyptolepis which resembles the *G. microlepidotus* of Agassiz in the small size of its scales. These scales, which are for the most part exfoliated, and which in no case show the sculpture characteristic of the genus, average less than two lines in diameter. The fins of the side exposed to view are tolerably well defined, and the outline of one of the slender, elongated and acute, lobate pectorals is somewhat clearly shown. The specimen agrees perfectly with Huxley's restoration of Glyptolepis, in the shape and position of its fins, and in the contour of its tail.

Glyptolepis. Compare *G. leptopterus* Ag.—A second species of Glyptolepis, apparently of the type of *G. leptopterus*, appears to be indicated in Mr. Foord's 1880 collections by two or three large isolated scales. These scales, which are nearly an inch in length, are ornamented with the wavy costæ and semilunar or crescentic area of backwardly directed points peculiar to the genus.

Cheirolepis canadensis.—Four fine and well preserved specimens of a large species of Cheirolepis, nearly related to the *C. cummingiæ* of Agassiz, of which it may prove to be only a local variety. According to Hugh Miller, the large pectorals of *C. cummingiæ* " almost encroach upon the ventrals, and the ventrals upon the anal," but this is by no means the case with the *C. canadensis.* In the latter species, or variety, the ventral fins are situated considerably in advance of the mid-length, and are separated from the pectorals by a short interval. The anal fin is placed much farther forwards than the dorsal, and is separated from the ventrals by a space slightly exceeding in length the height of the body at the commencement of the anal.

The analogies between the fossil fauna of the Upper Devonian rocks at Scaumenac, and that of the old red sandstone of Scotland and Russia are very striking. With the exception of Eusthenopteron, all the genera yet found at Scaumenac, are those with which the readers of Hugh Miller will be familiar. Of the seven genera of fishes found so far at Scaumenac, six occur also in Europe, and of the eight species collected by Mr. Foord, probably one-half will yet prove to be mere varietal forms of European species. The *Pterichthys canadensis* is most likely the same as the *Bothriolepis ornata* of Russia and Scotland; the Acanthodes appears to be referable to the *A. mitchelli* of Egerton; one of the species of Glyptolepis may be identical with the *G. microlepidotus* of Agassiz and the *Cheirolepis canadensis* is probably a variety of the *C. cummingiæ.*

The existence of fossil plants, as well as of fish remains, in the shales and sandstones of Scaumenac bay was noticed by Dr. Gesner in 1842, and from these rocks Mr. Foord also obtained a series of specimens of four species of ferns which have recently been described by Principal Dawson. These Devonian deposits at Scaumenac may have been of fresh water or estuarine origin, for no traces of any marine invertebrata have yet been detected in them, and the fossil fishes which they contain are invariably found associated with land plants.

On the south bank of the Restigouche, about half a mile above Campbellton, another series of fish-bearing strata was discovered by Mr. Ells in 1871. These deposits have also been carefully explored by Mr. Foord, and a preliminary description of the species collected by him has been published in Vol. x, No. 2, of the *Canadian Naturalist.* At this locality the remains of fishes occur in brecciated limestones of Lower Devonian age, which latter are much disturbed by trappean outbursts and overflows. The specimens, though sometimes well preserved, are generally fragmentary, and the species recognized so far are as follows:

Coccosteus acadicus.—Cranial shields and detached post-dorsomedian, ventromedian and preventrolateral plates of a species of Coccosteus whose characters appear to be intermediate between those of the *C. cuspidatus* and *C. decipiens* of Agassiz. The dorsomedian plate of *C. acadicus* is precisely like that of *C. cuspidatus*, but the superficial grooves on the cranial shields of the Campbellton specimens correspond perfectly with those represented in Hugh Miller's diagram of the head shield of *C. decipiens.* It is not at all unlikely that *C. decipiens, C. cuspidatus* and *C. acadicus* may eventually be found to be mere varietal forms of one somewhat variable species. So far all attempts at tracing out the true sutures on the cranial shields of the Campbellton Coccosteus have entirely failed, although one specimen has been ground down in the manner suggested by Professor Huxley.

Cephalaspis campbelltonensis.—Large head-shield of a Cephalaspis, probably belonging to the section Eucephalaspis of E. Ray Lankester, with the orbits well defined and the prominences and depressions of the central region very clearly shown. All the specimens are very much crushed and distorted and nearly all are exfoliated. Portions of the true outer layer of the test have been seen only on the central portion of the outer margin of the left hand side of one large fragment, and on the extremities of the cornua in two or three other specimens. The enamel of the true outer surface appears polished and nearly smooth to the naked eye, but under a lens it is seen to be minutely and densely pitted, the pits being very irregular in their shape, size and method of arrangement. Where the enamel is removed the surface is divided into numerous well-marked polygonal areas.

Including the *C. dawsoni* of Lankester, from Gaspé, all the species of Cephalaspis hitherto described are said to be characterized by a surface ornamented by raised tubercles, usually of very small size, so that the *C. campbelltonensis* may be readily distinguished by its minutely pitted sculpture.

Ctenacanthus latispinosus.—This species is represented in Mr. Foord's collection by a few fin-spines about two inches and a half in length, which are chiefly remarkable for the regularly nodose structure of their radiating ribs.

Homacanthus, sp. undt.—A single imperfect and badly preserved spine of a species of Homacanthus, which, as far as can be ascertained at present, resembles the *H. arcuatus* of Agassiz in almost every respect but that of size, the Campbellton species being much the larger of the two.

The fossil plants as well as fishes found at Campbellton appear to be entirely different to those of Scaumenac bay, and at the former locality entomostraca, *Spirorbis erianus*, fragments of a large Pterygotus, and two new species of Cyclora are associated with the fishes.